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I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2002950123 for a patent by DONNA SHEEHY and HUW TREERS as filed on 11 July 2002.

WITNESS my hand this
Sixteenth day of June 2003

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A SOIL ADDITIVE

FIELD OF THE INVENTION

The present invention relates to soil treatment and in particular to a soil additive to assist in ecologically sustainable development.

BACKGROUND ART

Treatment methods currently being used for soils include soil washing, incineration, and biotreatment. Soil washing involves removal of hazardous chemicals from soils using solvents, but the solvent stream must still be treated for destruction of contaminants. Incineration is an effective tool for destruction of contaminants but is costly and lacks public acceptance.

Bioremediation has been considered and used for treatment of soils contaminated with wood-treatment chemicals, but bioremediation leaves the most toxic, carcinogenic, and regulated chemicals in the soil. Slurry-phase biotreatment of contaminated soils and sediments is an innovative treatment technology. Its advantages include easy manipulation of physio-chemical variables and operating conditions to enhance rates of biodegradation and ease of containment of exhaust gases and effluent. Bio-slurry technology is currently hampered by some bottlenecks that need to be relieved.

Foam remediation technologies have the potential to increase the applicability of in-situ bioremediation. Unlike other approaches, foams can be designed to remove pollutants and enhance bioremediation simultaneously. Although foams have been applied successfully underground for enhanced oil recovery, they have not yet been systematically applied to environmental remediation problems closer to the surface. Developers are exploring the opportunity to adapt and mature this existing technology for environmental remediation purposes, such as for the cleanup of hazardous waste.

It is anticipated that foam remediation technology can be applied to both the saturated and vadose zones for remediation of soils contaminated with either chlorinated organics, such as trichloroethylene and carbon tetrachloride, or polyaromatic hydrocarbons, such as chrysene,

benz(a)anthracene, anthracene, fluoranthene, or phenanthrene.

Current technologies for the in-situ remediation of soils contaminated with metals also require invasive reagent delivery systems. Typical volume increases on the order of 20 to 30 percent are encountered and cost escalations are witnessed due to the mixing process. In order to eliminate the problems associated with mixing of the reagents and the contaminated soils, projects have explored the use of liquid stabilisation reagents for the in-situ remediation of soils contaminated with metals.

Field tests consist of applying two percent by weight of the geochemical fixation reagent to the top six inches of soil. The reagent is expected to be a form of fertiliser.

The above methods of remediation are cutting edge and are therefore often expensive or complex. Also the traditional method of treatment for remediation of acidic and acid sulfate soils (ASS) is to use a soil additive which is basic as opposed to acidic. The soil additive most generally used is a traditional carbonate derived from limestone or lime. These additives are associated with greenhouse gas emissions.

The inventors of the present invention found a surprising blend of volcanic, biogenic and sedimentary rocks, which accomplishes the pH rise well and in a balanced way. Biogenic sediments - including the carbonate, phosphatic, and biosiliceous sediments, as well as sedimentary organic carbon - record the spatial and temporal heterogeneity of biologically mediated sedimentary processes. In turn, biogenic sedimentation influences local, regional, and global atmospheric and oceanic environments, by acting as sinks for the nutrient elements that drive bio-geochemical cycles.

The inventors also found that their invention can be used in the following applications:

- For the development, management and remediation of acidic and acid sulfate soils (ASS);
- For the development, management and remediation of acidic materials and leachate;
- For use in agricultural practices, operation, remediation works and

development;

- For use in sandy materials to enhance treatment retention characteristics to reduce the effects of product leaching;
- For the management and remediation of earth materials and leachate involved with development, mining and construction industries;
- For the management and remediation of industrial waste; and
- For general use as partial or full replacement of traditional carbonate derived limestone and liming products to reduce greenhouse gas emissions.

OBJECT OF THE INVENTION

The present invention is directed to a soil additive, which may at least partially overcome the abovementioned disadvantages or provide the consumer with a useful or commercial choice.

In one form, the invention resides in a soil additive produced from blending source rocks wherein the final product contains at least one of andesite, limestone, dolomite, basalt and volcanic glass.

This invention may provide an anthropogenic input to soil or materials, using substances which natural processes may provide under theoretical-optimum environmental conditions, to address the problems of acidity, acidic conditions and many other environmental conditions.

Each source rock may preferably be crushed separately from the other types of source rock. The rock may also be ground to specific grain sizes to exploit each source rocks' target attributes. It may also allow for a degree of sustained breakdown or temporal management of the final product to facilitate dosage rate calculations.

The grinding and/or blending and spraying of the dusts may preferably be designed to exploit the crystalline structure of the target mineralogy of each component in the source rock. The blending stage may be used to encourage grain impregnation of the temporal and chemical target attribute requirement of the final product.

When crushing operations are carried out using wet methods, all

the crushing waters are preferably retained for blending with other crushing products, grinding products and any evaporates. Any production waters may preferably be retained for use in applications as a high abrasive pH liquid treatment product or in the dry product blending process.

In a preferred form, the invention resides in a soil additive produced from blending source rocks wherein the final product has a modal abundance of andesite in the range of 0-20%, limestone in the range of 0-40%, dolomite in the range of 50-90%, basalt in the range of 0-30% and volcanic glass in the range of 1-50%.

In this form, the product or final blend may preferably be used as a planning grade, long-term product. The product may possess a long life span allowing for use during the planning stage of development and agricultural activity. It may offer pH buffering abilities and material pH self-regulation enhancement. Another feature may preferably be an insitu retention ability suited to sandy materials and heavy leaching. The product may also possess indirect environmental benefits.

The product may be used for pre-development conditioning of substrate soils, agricultural liming practices to lower CO_2 emissions and fertilizer requirements, broad scale treatment practices of large volumes of soil and material and associated operations. In this form, the final product may preferably be crushed or ground to coarser grain sizes which may suitably range from approximately 60 microns to 4 mm.

In another preferred form, the invention resides in a soil additive produced from blending source rocks wherein the final product has a modal abundance of andesite in the range of 0-15%, limestone in the range of 0-45%, dolomite in the range of 50-80%, basalt in the range of 0-40% and volcanic glass in the range of 1-50%.

In this form, the product or final blend may preferably be used as a management grade, short-term product. The product may possess a medium life span with high product retention ability.

The product may preferably be used for open-air operations involving acid sulfate soil (ASS) horizons, infrastructure bunding/protection in

acidic soils/substrates, ongoing mine tailings treatment, and agricultural liming practices to lower CO_2 emissions and fertilizer requirements. In this form, the final product may preferably be crushed or ground to finer grain sizes which may suitably range from approximately 20 microns to 2 mm.

In yet another preferred form, the invention resides in a soil additive produced from blending source rocks wherein the final product has a modal abundance of andesite in the range of 0-15%, limestone in the range of 0-45%, dolomite in the range of 50-75%, basalt in the range of 0-40% and volcanic glass in the range of 1-50%.

In this form, the product or final blend may preferably be used as a shock grade, immediate product. The product may possess a moderate life span with immediate active results in raising the pH of soils, material and associated leachate.

The product may preferably be used for acidic leachate-generating event management, urgent soil, water and material pH buffering, treatment of ASS and acidic materials and agricultural liming practices to lower CO_2 emissions and fertilizer requirements. In this form, the final product may preferably be crushed or ground to finer grain sizes which may suitably range from approximately 50 microns to 2 mm.

In still another preferred form, the invention resides in a soil additive produced from blending source rocks in the form of blending the crushing waters from crushing a first source rock containing at least one of andesite, limestone, dolomite, basalt and volcanic glass with the crushing waters from crushing at least one second source rock containing at least one of andesite, limestone, dolomite, basalt and volcanic glass.

In this form, the product or final blend may preferably be used as an all-purpose grade, pH raising liquid concentrate. The product may be used as a liquid shock treatment, dilutable to dosage and risk requirements/grade strength. It may be suitable for an extensive range of operations and applications.

The product may preferably be used for acidic leachate-generating event management, urgent soil, water and material pH buffering,

treatment of ASS and acidic materials and agricultural liming practices to lower CO_2 emissions and fertilizer requirements. In this form, the final product may preferably be concentrated to achieve a dilutable liquid pH buffering solution and treatment spray.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments of the invention will be described with reference to the following drawings, in which:

Figure 1 shows the process according to one preferred aspect of the invention.

Figure 2 shows the process according to another preferred aspect of the invention.

Figure 3 shows the process according to yet another preferred aspect of the invention.

Figure 4 shows the process according to still another preferred aspect of the invention.

BEST MODE

According to a first aspect of the invention, a soil additive produced from blending source rock containing at least one of andesite, limestone, dolomite, basalt and volcanic glass, is provided.

As can be seen from Figure 1, the soil additive is a blend wherein the final product contains components in given modal abundance.

According to the invention, the products of each embodiment undergo a series of processes. The differing products are formed by the application of different combinations of processes on source rock containing similar components. The different processes and particularly the blending stage 17 allow the invention to form different products with the desired minerals or rocks in required modal abundance in the product.

Unless otherwise stated in the following description, the lines of andesite, limestone, dolomite, basalt and volcanic glass are all processed separately and even the crushing waters are kept separately for later reuse.

In a first embodiment, the final product is produced according to the production flowsheet given in Figure 1 and is the planning grade product described above. The overall process may be explained by analyzing the series of subsidiary processes involved.

The source rock or rocks undergo analysis to determine mineralogy and/or the crystalline structure 13 of the rocks.

The next step is crushing 11 the source rocks to a particular size fraction. In this embodiment, the size fraction required at this stage is in the range of 60 microns up to 2 mm. The crushing 11 may be performed under wet or dry conditions. If performed under wet conditions, the crushing waters from each source rock are collected 14. As can be appreciated, if the crushing is performed under wet conditions, water is generally used in the process. This forms a water/rock slurry of suspension having particulate matter from the source rocks suspended in the water. This suspension can be used according to an embodiment of the invention as a soil additive.

After the crushing stage 11, all production lines are subjected to size determination 12 to ensure the correct size fraction from the crushing stage 11. The dolomite and volcanic glass lines are also subjected to neutralising value and/or attribute analysis 10.

The next step for all production lines is stockpiling and/or drying 15. This stage removes some of the waters that may have been added in the crushing stage 11.

The next step is the grinding stage 16. Grinding is a process utilizing machinery different to that used in the crushing stage 11. Crushing generally gives a coarser product than grinding. All lines are ground to give a size fraction in the range of 40 microns to 3 mm.

After the grinding stage 16, the limestone and dolomite production lines are again tested for neutralising value and/or attribute analysis 10.

The basalt and volcanic glass lines undergo blending/refining 17 before proceeding to a spraying stage 18 where the blended lines are sprayed using crushing waters 21. The blend is sprayed using approximately

1 to 1000 liters of crushing waters 21.

The blended line is then further blended or refined 17 to ensure the required quantity of each rock or mineral is present before they are further blended 17 with the dolomite and limestone lines which exit the neutralising value and/or attribute analysis 10.

The blend of four minerals/rocks is then sprayed 18 with a range of about 1 to 500 litres of crushing waters and the excess water is collected 14.

The blend of four minerals/rocks is then dried 15 to remove excess waters which are collected 14. The blend is then further blended with the andesite exiting the grinding stage 16 to form the final product under this embodiment.

The final stage in this process is a quality check of neutralising value and/ attribute analysis to ensure product quality and that the required rocks/minerals are present in the desired modal abundances. The product then proceeds to packing and distribution.

According to a second embodiment, the final product is produced according to the production flowsheet given in Figure 2 and is the management grade product described above. The overall process may be explained by analyzing the series of subsidiary processes involved.

The source rock or rocks undergo analysis to determine mineralogy and/or the crystalline structure 13 of the rocks.

The next step is crushing 11 the source rocks to a particular size fraction. In this embodiment, the size fraction required at this stage is in the range of 60 microns up to 3 mm. The crushing 11 may be performed under wet or dry conditions. If performed under wet conditions, the crushing waters from each source rock are collected 14. As can be appreciated, if the crushing is performed under wet conditions, water is generally used in the process. This forms a water/rock slurry of suspension having particulate matter from the source rocks suspended in the water. This suspension can be used according to an embodiment of the invention as a soil additive.

After the crushing stage 11, all production lines are subjected to

size determination 12 to ensure the correct size fraction from the crushing stage 11. The dolomite and volcanic glass lines are also subjected to neutralising value and/or attribute analysis 10.

The next step for all production lines is stockpiling and/or drying 15. This stage removes some of the waters that may have been added in the crushing stage 11.

The next step is the grinding stage 16. Grinding is a process utilizing machinery different to that used in the crushing stage 11. Crushing generally gives a coarser product than grinding. All lines are ground to give a size fraction in the range of 40 microns to 2.5 mm except the volcanic glass line which is ground to give a size fraction in the range of 40 microns to 3 mm.

After the grinding stage 16, the limestone and dolomite production lines are again tested for neutralising value and/or attribute analysis 10.

The basalt and volcanic glass lines undergo blending/refining 17 before proceeding to a spraying stage 18 where the blended lines are sprayed using crushing waters 21. The blend is sprayed using approximately 1 to 500 liters of crushing waters 21.

The blended line is then further blended or refined 17 to ensure the required quantity of each rock or mineral is present. The blended lines are then dried 15 before they are further blended 17 with the dolomite and limestone lines which exit the neutralising value and/or attribute analysis 10 step.

The blend of four minerals/rocks is then sprayed 18 with a range of about 1 to 1000 litres of crushing waters and the excess water is collected 14.

The blend of four minerals/rocks is then dried 15 to remove excess waters which are collected 14. The blend is then further blended with the andesite exiting the grinding stage 16 to form the final product under this embodiment.

The final stage in this process is a quality check of neutralising value and/ attribute analysis to ensure product quality and that the required

rocks/minerals are present in the desired modal abundances. The product then proceeds to packing and distribution.

According to a third embodiment, the final product is produced according to the production flowsheet given in Figure 3 and is the shock grade product described above. The overall process may be explained by analyzing the series of subsidiary processes involved.

The source rock or rocks undergo analysis to determine mineralogy and/or the crystalline structure 13 of the rocks.

The next step is crushing 11 the source rocks to a particular size fraction. In this embodiment, the size fraction required at this stage is in the range of 60 microns up to 3 mm. The crushing 11 may be performed under wet or dry conditions. If performed under wet conditions, the crushing waters from each source rock are collected 14. As can be appreciated, if the crushing is performed under wet conditions, water is generally used in the process. This forms a water/rock slurry of suspension having particulate matter from the source rocks suspended in the water. This suspension can be used according to an embodiment of the invention as a soil additive.

After the crushing stage 11, all production lines are subjected to size determination 12 to ensure the correct size fraction from the crushing stage 11. The dolomite and volcanic glass lines are also subjected to neutralising value and/or attribute analysis 10.

The next step for all production lines is stockpiling and/or drying 15. This stage removes some of the waters that may have been added in the crushing stage 11.

The next step for each of the andesite, limestone and dolomite lines is the grinding stage 16. Grinding is a process utilizing machinery different to that used in the crushing stage 11. Crushing generally gives a coarser product than grinding. All lines including the blend are ground to give a size fraction in the range of 40 microns to 2 mm.

After the grinding stage 16, the limestone and dolomite production lines are again tested for neutralising value and/or attribute analysis 10.

The basalt and volcanic glass lines exiting the drying stage 15 are blended/refined 17 together before being ground 16. The blended lines then undergo further blending 17 to achieve the required composition before proceeding to a spraying stage 18 where the blended lines are sprayed using crushing waters 21. The blend is sprayed using approximately 1 to 1500 liters of andesite crushing waters 21.

The blended line is then further blended or refined 17 to ensure the required quantity of each rock or mineral is present before they are dried 15 to remove excess waters.

There is then a split of the two blended lines so that some may be reintroduced at a later stage.

The two blended lines are then further blended 17 with the dolomite and limestone lines which exit the neutralising value and/or attribute analysis 10 and the andesite line from the grinding 16 stage.

The blend of all minerals/rocks is then sprayed 18 with a range of about 1 to 1500 litres of crushing waters and the excess water is collected 14.

The blend is then dried 15 to remove excess waters which are collected 14.

The blend of basalt and volcanic glass that was split off earlier undergoes neutralising value and/or attribute analysis 10. This blend is then reintroduced to the five-way blend exiting the last drying stage 15 to form the final product under this embodiment.

The final stage in this process is a quality check of neutralising value and/ attribute analysis to ensure product quality and that the required rocks/minerals are present in the desired modal abundances. The product then proceeds to packing and distribution.

According to a fourth embodiment, the crushing waters from each of the previously described embodiments are used to produce a liquid all grade pH buffering product.

The crushing waters contain particulate material from each of the five minerals/rocks in suspension. The crushing waters first undergo

neutralising value and/or attribute analysis 13 to determine their properties and relative strengths.

Each line then undergoes a size determination step 10 to determine whether the crushing waters require further processing prior to blending 17.

Each line then undergoes a product concentration step 19 to ensure that the required mineral/rock is present in the desired quantity.

Each line is then sieved to remove any oversize particulate matter from the liquid.

Each line then proceeds to a neutralising value and/or attribute analysis step 13.

The crushing waters 21 then are used for all of the spraying steps 18 in all embodiments and are not added to the final liquid blend under this embodiment.

After the neutralising value and/or attribute analysis step 13, the dolomite and basalt lines are blended 17 together as are the limestone and volcanic glass lines.

The limestone and volcanic glass blend undergoes a further product concentration step 19, before both blends are mixed 17 to form the final product under this embodiment.

The final product undergoes mineralogy and/or crystalline structure analysis 10 and neutralising value and/or attribute analysis 13 before proceeding to packaging and distribution.

In the present specification and claims, the word "comprising" and its derivatives including "comprises" and "comprise" include each of the stated integers but does not exclude the inclusion of one or more further integers.

In compliance with the statute, the invention has been described in language more or less specific to structural or methodical features. It is to be understood that the invention is not limited to specific features shown or described since the means herein described comprises preferred forms of putting the invention into effect. The invention is, therefore, claimed in any of

its forms or modifications within the proper scope of the description appropriately interpreted by those skilled in the art.

Dated this 11th day of July 2002

Huw Treers and Donna Sheehy

By their Patent Attorneys

CULLEN&CO

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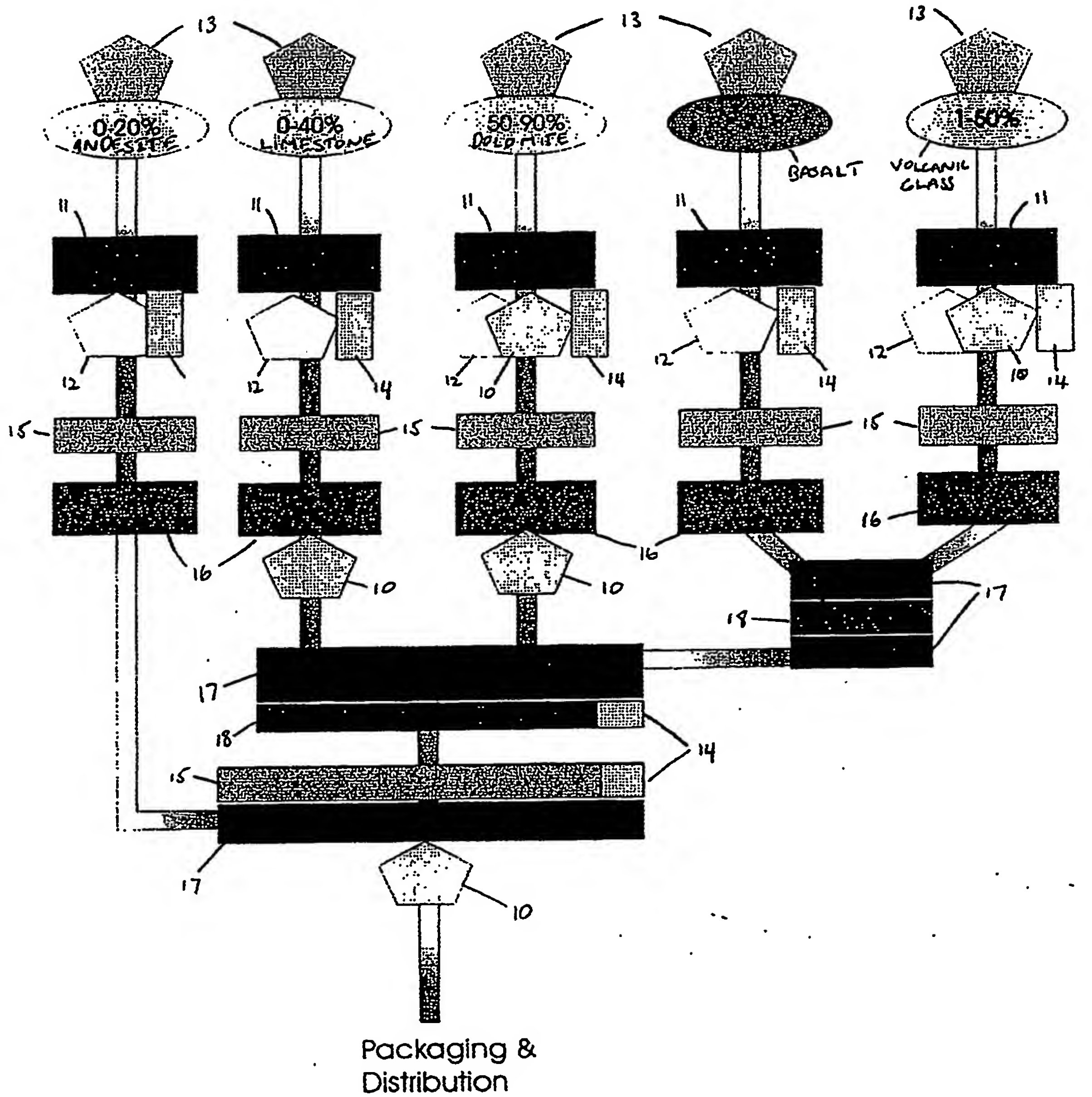
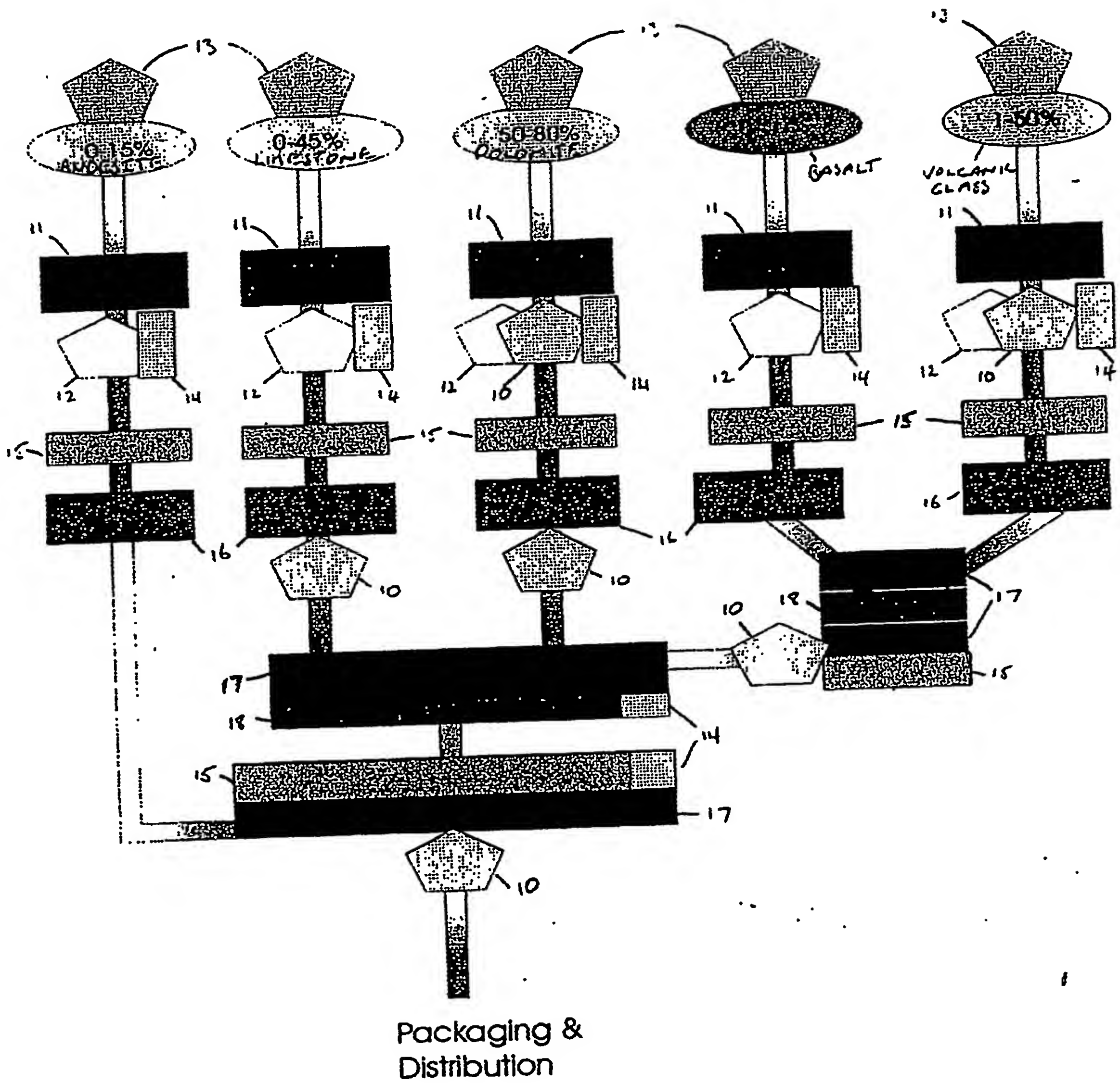
FIGURE 1



0-20%
ANDESITE
0-40%
LIMESTONE
50-90%
DOLOMITE
BASALT
1-60%
VOLCANIC GLASS
Packaging &
Distribution

FIGURE 2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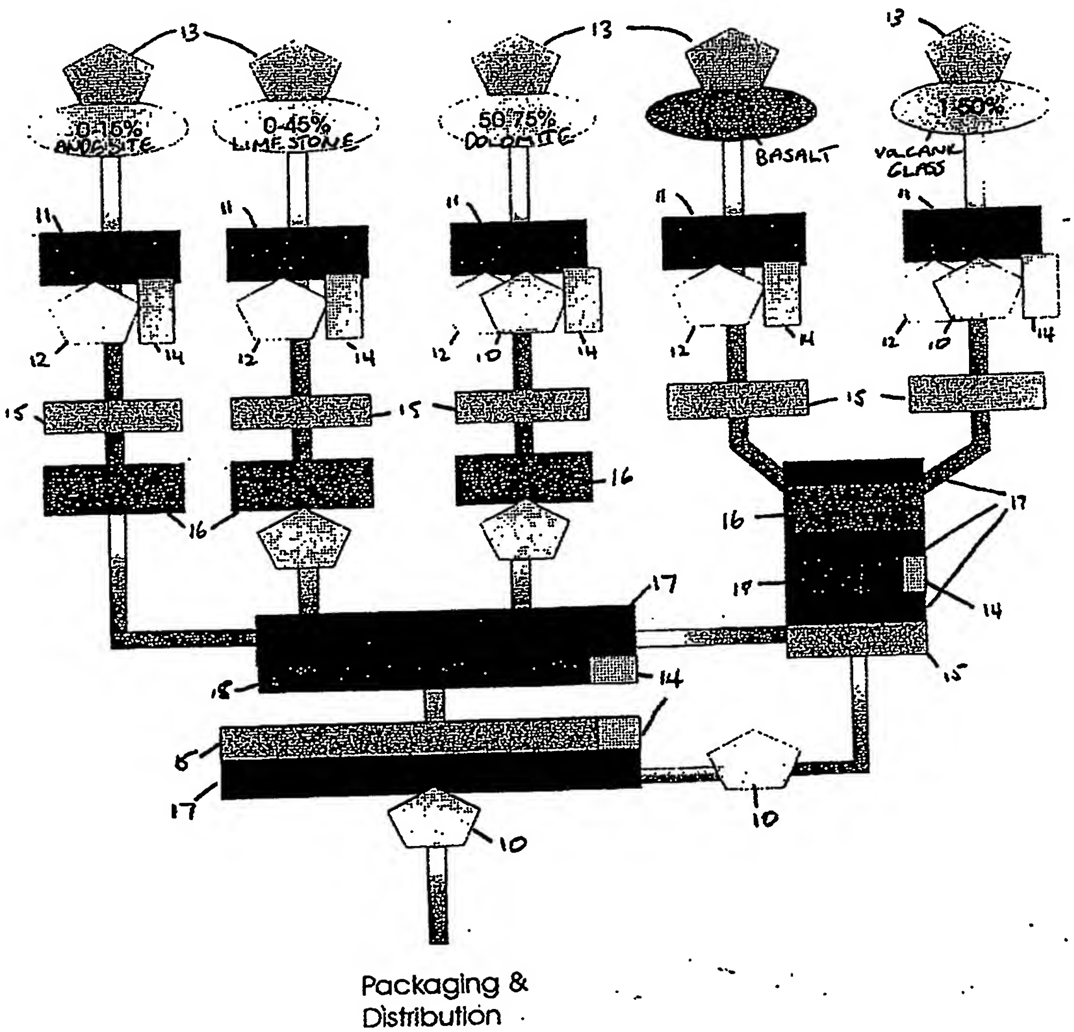
ANDESITE
0-45%
LIMESTONE
50-80%
BASALT
1-60%
VOLCANIC GLASS
Packaging &
Distribution

FIGURE 3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DOLOMITE
BASALT
1-50%
VOLCANIC
GLASS
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Packaging &
Distribution

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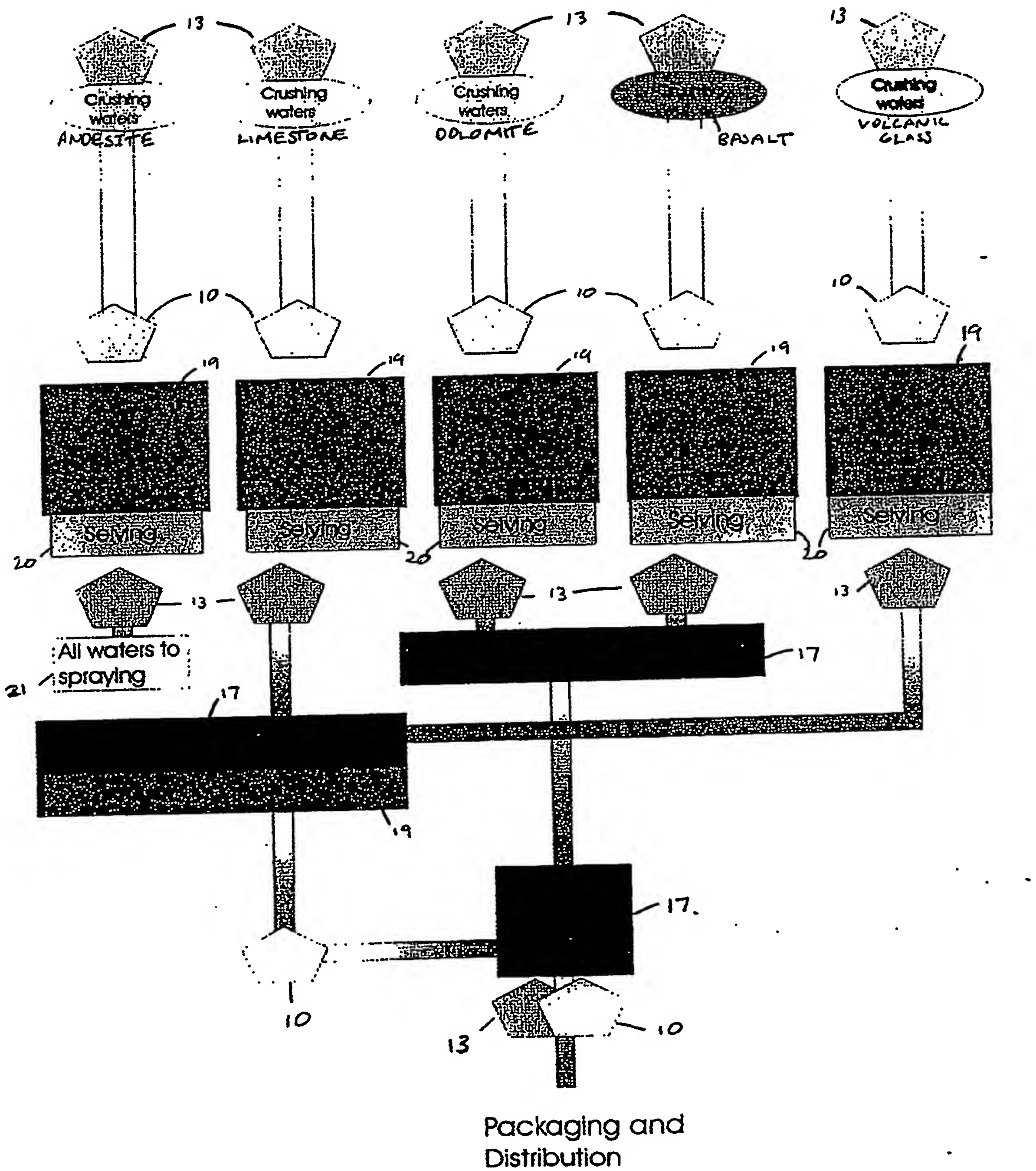
FIGURE 4



13
Crushing waters
ANDESITE
Crushing waters
LIMESTONE
Crushing waters
DOLOMITE
BASALT
Crushing waters
VOLCANIC GLASS
10
19
Seiving
20
All waters to spraying
21
17
Packaging and Distribution